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PHILOSOPHICAL
T R A N S A C T I O N S
OF THE
R O Y A L S O C I E T Y
OF
L O N D O N.

FOR THE YEAR MDCCCXXXVIII.

PART I.

LONDON:

PRINTED BY RICHARD AND JOHN E. TAYLOR, RED LION COURT, FLEET STREET.

MDCCCXXXVIII.

ADVERTISEMENT.

THE Committee appointed by the *Royal Society* to direct the publication of the *Philosophical Transactions*, take this opportunity to acquaint the Public, that it fully appears, as well from the Council-books and Journals of the Society, as from repeated declarations which have been made in several former *Transactions*, that the printing of them was always, from time to time, the single act of the respective Secretaries till the Forty-seventh Volume; the Society, as a Body, never interesting themselves any further in their publication, than by occasionally recommending the revival of them to some of their Secretaries, when, from the particular circumstances of their affairs, the *Transactions* had happened for any length of time to be intermitted. And this seems principally to have been done with a view to satisfy the Public, that their usual meetings were then continued, for the improvement of knowledge, and benefit of mankind, the great ends of their first institution by the Royal Charters, and which they have ever since steadily pursued.

But the Society being of late years greatly enlarged, and their communications more numerous, it was thought advisable that a Committee of their members should be appointed, to reconsider the papers read before them, and select out of them such as they should judge most proper for publication in the future *Transactions*; which was accordingly done upon the 26th of March 1752. And the grounds of their choice are, and will continue to be, the importance and singularity of the subjects, or the advantageous manner of treating them; without pretending to answer for the certainty of the facts, or propriety of the reasonings, contained in the several papers so published, which must still rest on the credit or judgement of their respective authors.

It is likewise necessary on this occasion to remark, that it is an established rule of the Society, to which they will always adhere, never to give their opinion, as a Body,

upon any subject, either of Nature or Art, that comes before them. And therefore the thanks, which are frequently proposed from the Chair, to be given to the authors of such papers as are read at their accustomed meetings, or to the persons through whose hands they received them, are to be considered in no other light than as a matter of civility, in return for the respect shown to the Society by those communications. The like also is to be said with regard to the several projects, inventions, and curiosities of various kinds, which are often exhibited to the Society ; the authors whereof, or those who exhibit them, frequently take the liberty to report and even to certify in the public newspapers, that they have met with the highest applause and approbation. And therefore it is hoped that no regard will hereafter be paid to such reports and public notices ; which in some instances have been too lightly credited, to the dishonour of the Society.

A List of Public Institutions and Individuals, entitled to receive a copy of the Philosophical Transactions of each year, on making application for the same directly or through their respective agents, within five years of the date of publication.

In the British Dominions.

The King's Library.
The Admiralty Library.
The Radcliffe Library, Oxford.
The Royal Geographical Society.
The United Service Museum.
The Royal College of Physicians.
The Society of Antiquaries.
The Linnean Society.
The Royal Institution of Great Britain.
The Society for the Encouragement of Arts.
The Geological Society.
The Horticultural Society.
The Royal Astronomical Society.
The Royal Asiatic Society.
The Royal Society of Literature.
The Medical and Chirurgical Society.
The London Institution.
The Entomological Society of London.
The Zoological Society of London.
The Institute of British Architects.
The Institution of Civil Engineers.
The Cambridge University Philosophical Society.
The Royal Society of Edinburgh.
The Royal Irish Academy.
The Royal Dublin Society.
The Asiatic Society at Calcutta.
The Royal Artillery Library at Woolwich.
The Royal Observatory at Greenwich.
The Observatory at Dublin.
The Observatory at Armagh.
The Observatory at the Cape of Good Hope.
The Observatory at Madras.
The Observatory at Paramatta.

Denmark.

The Royal Society of Sciences at Copenhagen.
The Royal Observatory at Altona.

France.

The Royal Academy of Sciences at Paris.
The Royal Academy of Sciences at Thoulouse.
The École des Mines at Paris.
The Geographical Society at Paris.

The Entomological Society of France.
The Dépôt de la Marine, Paris.
The Geological Society of France.
The Jardin des Plantes, Paris.

Germany.

The University at Göttingen.
The Cæsarean Academy of Naturalists at Bonn.
The Observatory at Manheim.

Italy.

The Italian Society of Sciences at Modena.
The Royal Academy of Sciences at Turin.

Switzerland.

The Société de Phys. et d'Hist. Nat. at Geneva.

Belgium.

The Royal Academy of Sciences at Brussels.

Netherlands.

The Royal Institute of Amsterdam.

Spain.

The Royal Observatory at Cadiz.

Portugal.

The Royal Academy of Sciences at Lisbon.

Prussia.

The Royal Academy of Sciences at Berlin.

Russia.

The Imperial Academy of Sciences at St. Petersburg.

Sweden and Norway.

The Royal Academy of Sciences at Stockholm.
The Royal Society of Sciences at Drontheim.

United States.

The American Philosophical Society at Philadelphia.
The New York Philosophical Society.
The American Academy of Sciences at Boston.
The Library of Harvard College.

The *fifty* Foreign Members of the Royal Society.

A List of Public Institutions and Individuals, entitled to receive a copy of the Astronomical Observations made at the Royal Observatory at Greenwich, on making application for the same directly or through their respective agents, within two years of the date of publication.

In the British Dominions.

The King's Library.
The Board of Ordnance.
The Royal Society.
The Savilian Library, Oxford.
The Library of Trinity College, Cambridge.
The King's Observatory at Richmond.
The Royal Observatory at Greenwich.
The University of Aberdeen.
The University of St. Andrews.
The University of Dublin.
The University of Edinburgh.
The University of Glasgow.
The Observatory at Oxford.
The Observatory at Cambridge.
The Observatory at Dublin.
The Observatory at Armagh.
The Observatory at the Cape of Good Hope.
The Observatory at Paramatta.
The Observatory at Madras.
The Royal Institution of Great Britain.
The Royal Society, Edinburgh.
The Astronomical Institution, Edinburgh.
The President of the Royal Society.
The Lowndes's Professor of Astronomy, Cambridge.
The Plumian Professor of Astronomy, Cambridge.
Francis Baily, Esq. V.P. and Treas. R.S.
Thomas Henderson, Esq. of Edinburgh.
John William Lubbock, Esq.
Captain W. H. Smyth, R.N. of Bedford.
Sir James South, Observatory, Kensington.

In Foreign Countries.

The Royal Academy of Sciences at Berlin.
The Royal Academy of Sciences at Paris.
The Imperial Academy of Sciences at St. Petersburg.
The Royal Academy of Sciences at Stockholm.
The Royal Society of Sciences at Upsal.
The Board of Longitude of France.
The University of Göttingen.
The University of Leyden.
The Academy of Bologna.
The American Academy of Sciences at Boston.
The American Philosophical Society at Philadelphia.
The Library of Harvard College.
The Observatory at Helsingfors.
The Observatory at Altona.
The Observatory at Berlin.
The Observatory at Brussels.
The Observatory at Cadiz.
The Observatory at Coimbra.
The Observatory at Copenhagen.
The Observatory at Dorpat.
The Observatory at Königsberg.
The Observatory at Manheim.
The Observatory at Marseilles.
The Observatory at Milan.
The Observatory at Palermo.
The Observatory at Paris.
The Observatory at Seeberg.
The Observatory at Vienna.
The Observatory at Tubingen.
The Observatory at Wilna.
Professor Bessel, of Königsberg.
Dr. William Olbers, of Bremen.
The Dépôt de la Marine, Paris.
The Bowden College, United States.
The Waterville College, United States.

ROYAL MEDALS.

HER MAJESTY QUEEN VICTORIA, in restoring the Foundation of the Royal Medals, has been graciously pleased to approve of the following regulations for the award of them :

That the Royal Medals be given for such papers only as have been presented to the Royal Society, and inserted in their Transactions.

That the triennial Cycle of subjects be the same as that hitherto in operation : viz.

1. Astronomy ; Physiology, including the Natural History of Organized Beings.
2. Physics ; Geology and Mineralogy.
3. Mathematics ; Chemistry.

That, in case no paper, coming within these stipulations, should be considered deserving of the Royal Medal, in any given year, the Council have the power of awarding such Medal to the author of any other paper on either of the several subjects forming the Cycle, that may have been presented to the Society and inserted in their Transactions ; preference being given to the subjects of the year immediately preceding : the award being, in such case, subject to the approbation of Her Majesty.

The Council propose to give one of the Royal Medals in the present year (1838) for the most important unpublished paper in Mathematics, communicated to the Royal Society for insertion in their Transactions after the termination of the Session in June 1835, and prior to the termination of the present Session (June 1838).

The Council propose also to give one of the Royal Medals in the present year (1838)

for the most important unpublished paper in Chemistry, communicated to the Royal Society for insertion in their Transactions after the termination of the Session in June 1835, and prior to the termination of the present Session (June 1838).

The Council propose to give one of the Royal Medals in the year 1839 for the most important unpublished paper in Astronomy, communicated to the Royal Society for insertion in their Transactions after the termination of the Session in June 1836, and prior to the termination of the Session in June 1839.

The Council propose to give also one of the Royal Medals in the year 1839 for the most important unpublished paper in Physiology, including the Natural History of Organized Beings, communicated to the Royal Society for insertion in their Transactions after the termination of the Session in June 1836, and prior to the termination of the Session in June 1839.

The Council propose to give one of the Royal Medals in the year 1840 for the most important unpublished paper in Physics, communicated to the Royal Society for insertion in their Transactions after the termination of the Session in June 1837, and prior to the termination of the Session in June 1840.

The Council propose also to give one of the Royal Medals in the year 1840 for the most important unpublished paper in Geology or Mineralogy, communicated to the Royal Society for insertion in their Transactions after the termination of the Session in June 1837, and prior to the termination of the Session in June 1840.

The Council propose to give one of the Royal Medals in the year 1841 for the most important unpublished paper in Mathematics, communicated to the Royal Society for insertion in their Transactions after the termination of the Session in June 1838, and prior to the termination of the Session in June 1841.

The Council propose also to give one of the Royal Medals in the year 1841 for the most important unpublished paper in Chemistry, communicated to the Royal Society for insertion in their Transactions after the termination of the Session in June 1838, and prior to the termination of the Session in June 1841.

ADJUDICATION of the MEDALS of the ROYAL SOCIETY for the year 1837 by
HIS ROYAL HIGHNESS the PRESIDENT and COUNCIL.

A COPLEY MEDAL to M. BECQUEREL, for his various Memoirs on the subject of Electricity, published in the “Mémoires de l’Académie Royale des Sciences de l’Institut de France,” and particularly those on the Production of Crystals of Metallic Sulphurets and Sulphur, by the long-continued action of Electricity of very low tension, and published in the tenth volume of those “Mémoires.”

Another COPLEY MEDAL to JOHN FREDERICK DANIELL, Esq., F.R.S., for his two papers “On Voltaic Combinations,” published in the Philosophical Transactions for 1836.

The ROYAL MEDAL, in the department of Physics, to the Rev. WILLIAM WHEWELL, M.A., F.R.S., for his “Researches connected with the Theory of the Tides,” communicated to the Royal Society, and published in its Transactions within the three preceding years.

The ROYAL MEDAL, in the department of Geology, for the year 1837, was not awarded.

C O N T E N T S.

- I. *Experimental Researches in Electricity.—Eleventh Series.* By MICHAEL FARADAY, Esq., D.C.L. F.R.S., Fullerian Prof. Chem. Royal Institution, Corr. Memb. Royal and Imp. Acadd. of Sciences, Paris, Petersburg, Florence, Copenhagen, Berlin, &c. &c. page 1

- II. *Fourth Letter on Voltaic Combinations, with reference to the Mutual Relations of the Generating and Conducting Surfaces. Addressed to MICHAEL FARADAY, Esq., D.C.L. F.R.S., Fullerian Prof. Chem. Royal Institution, &c. &c. &c. By J. FREDERIC DANIELL, F.R.S., Prof. Chem. in King's College, London.* . . 41

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C O N T E N T S.

- IX. **THE BAKERIAN LECTURE.**—*On the Theory of the Astronomical Refractions.* By JAMES IVORY, K.H. M.A. F.R.S. L. & E., Instit. Reg. Sc. Paris, Corresp. et Reg. Sc. Götting. Corresp. page 169
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Meteorological Journal kept at the Apartments of the Royal Society, by order of the President and Council.

ADJUDICATION of the MEDALS of the ROYAL SOCIETY for the year 1838 by
HIS ROYAL HIGHNESS the PRESIDENT and COUNCIL.

The RUMFORD MEDAL to JAMES DAVID FORBES, Esq., F.R.S., for his "Experiments on the Polarization of Heat," published in the Transactions of the Royal Society of Edinburgh.

A COPLEY MEDAL to Professor K. F. GAUSS, Forn. Memb. R.S., for his "Inventions and Mathematical Researches on Magnetism."

Another COPLEY MEDAL to MICHAEL FARADAY, Esq., D.C.L., F.R.S., for his "Researches on Specific Electrical Induction."

The ROYAL MEDAL, in the department of Chemistry, to THOMAS GRAHAM, Esq., M.A., F.R.S., for his paper entitled "Inquiries respecting the Constitution of Salts, of Oxalates, Nitrates, Phosphates, Sulphates, and Chlorides," published in the Philosophical Transactions for 1836.

The ROYAL MEDAL, in the department of Mathematics, to WILLIAM HENRY FOX TALBOT, Esq., F.R.S., for his papers entitled "Researches in the Integral Calculus," published in the Philosophical Transactions for 1836 and 1837.